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Design and installation of continuous flow and water quality monitoring stations to improve water quality forecasting in the lower San Joaquin River

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Water quality models are only as useful as the monitoring data that feeds them. These stations provide critical west-side river inflow data that hitherto had been lacking and which, until the stations were installed, had continued to compromise San Joaquin River flow and water quality models. As conditions in the watershed change in response to environmental regulation and EPA-mandated TMDL's - assumptions and heuristics concerning seasonality of flow and water quality in the San Joaquin River break down and no longer are applicable. There is no substitute for good data.

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Appendix A

San Joaquin River tributary flow and water quality monitoring

Introduction

The Dissolved Oxygen TMDL monitoring program for continuously reported data was designed to "piggy-back" to the largest extent on existing water district and agency monitoring programs. Where stations did not current exist, locations were chosen with the help of the agricultural water districts consistent the following guiding principles :

1. The sites should be easily accessible and access granted by the landowner
2. The sites should be secure to the extent possible and not prone to vandalism
3. Sites should be prioritized according to contribution of flow and contaminant loading (algae, salt, sediment, nutrients, temperature)
4. Existing monitoring stations should be rehabilitated and enhanced in capability where possible
5. Water districts should be willing to assist and capable of taking over long-term maintenance of the sites
6. Monitoring equipment should be chosen to be compatible with existing water district telemetry and/or SCADA systems. Water Districts should be involved in the selection of sensor hardware.
7. Planned changes in watershed hydrology (such as construction of terminal reservoirs) should be considered in station location decisions.

Monitoring Parameters

The main objectives of the continuous flow and water quality monitoring program are:

1. To measure the flow rate, temperature and the salinity and calculate the total salt load of the major tributary inflows to the San Joaquin River.
2. Using these data to calculate algal, sediment and nutrient loading to the San Joaquin River and provide these data to those individuals responsible for water quality modeling.

3. To provide a conservative tracer against which other conservative and non-conservative water quality parameters can be compared.

4. To report these data on a real-time basis, where possible, through the use of the Internet. This data network would become the backbone of a real-time decision support system for managing algal loading in the San Joaquin River.

Measurement of flow is the most difficult and costly of the continuously recorded parameters in the San Joaquin River Dissolved Oxygen TMDL monitoring program. Measurement of flow at individual sites depend upon the site characteristics and typically requires a control structure of some form (weir, culvert, flume) for accurate measurement. In instances where a convenient control structure was not available a stage to discharge measurement (with computation of a rating curve) was developed for open channels. The channel segment chosen for observation should be straight and unobstructed, with a stable bed configuration and not subject to backwater conditions. Where backwater conditions were likely or where closed pipes or culverts were involved acoustic Doppler transducers were deployed which provide both stage and velocity readings. These Doppler transducers, during operation, produce short pulses of sound at a known frequency along two different axes. Sound from the outgoing pulses is reflected ("scattered") in all directions by particulate matter in the water. Some portion of the scattered energy travels back along the beam axes to the transducer. These return signals have a frequency shift proportional to the velocity of the scattering material. This frequency change (Doppler shift), as measured by the circuitry within the transducer, is proportional to the projection of the water velocity onto the axis of each acoustic beam. By combining data from both beams, and knowing the relative orientation of those beams, the device measures velocity in the two-dimensional plane defined by its two acoustic beams. To obtain flow estimates from these Doppler transducers the readings of stage and vector velocity were combined with information on the stage to cross-sectional area relationship at the site. In some instances, such as deep culverts, which were not easily accessible, both control structure and acoustic sensors were deployed in concert. At these sites direct observation of flow conditions was difficult and in some circumstances hazardous. A comparison of the redundant measurements provided a quick quality assurance check – saving time and effort.

Salinity content was measured by sampling the electrical conductivity of the water. Electrical conductivity (EC), measured in micro-Siemens per centimeter [uS/cm], is a measure of the ions present in the water. The ions present in west-side return flows consist mainly of Calcium (Ca^+), Magnesium (Mg^+), Sodium (Na^+), and Potassium (K^+) cations and Bicarbonate (HCO_3^-), Sulfate (SO_4^-) and Chloride (Cl^-) anions. There is a direct relationship between EC in uS/cm and TDS in mg/L. The flow and EC data can be used for the computation of the total salt loading to and from the GWD. The computation to convert the flow and EC readings in cfs and uS/cm respectively, to total salt load in tons of salt per day [tpd] follows:

Equation 1

$$SaltLoad = M \times Q \times EC$$

where Q is in cubic feet per second [cfs], EC is in miro Siemens per centimeter [uS/cm] and M is the ratio of TDS [mg/L] to EC [uS/cm]. M is determined experimentally and is typically 0.75 in the Grassland Basin (California Environmental Protection Agency, 2002). Converting salt load into tons per day [tpd] Equation 1 becomes:

Equation 2

$$SaltLoad[tpd] = \frac{M\left[\frac{mg/L}{uS/cm}\right] \times Q\left[\frac{cu.ft.}{\sec}\right] \times EC\left[\frac{uS}{cm}\right] \times 28.32\left[\frac{L}{cu.ft.}\right] \times 2.2046\left[\frac{lb.}{kg}\right] \times 86{,}400\left[\frac{\sec}{day}\right]}{1{,}000{,}000\left[\frac{mg}{kg}\right] \times 2{,}000\left[\frac{lb}{ton}\right]}$$

or, simplified, it becomes:

Equation 3

$$SaltLoad[tpd] = Q[cfs] \times EC\left[\frac{uS}{cm}\right] \times 0.002023$$

Monitoring Station Operation

Flow transducers and electrical conductivity (EC) sensors were installed at control structures within the watershed. These sampling devices were programmed to take measurements every 15 minutes (with the exception of the east-side stations which recorded hourly) to provide an accurate measurement of flow and salt loading to the San Joaquin River. Flow and EC data at each site are collected using battery-powered datalogger in most circumstances that communicates through a telemetry system (either telephone or satellite), allowing these data to be accessed 24 hours a day. Several of the east-side stations had power on-site that obviated the need for self-powered sensors and telemetry equipment.

Telemetry

Most of the new and upgraded existing west-side stations were all equipped with GOES radios (others use cellular phone or land line telemetry) allowing them to report data every 15 minutes to the orbiting GOES satellite. A DOMSAT station is operated by the Department of Water Resources CDEC (California Data Exchange Center) which reports the data automatically downloaded from the satellite on the DWR CDEC website. In instances where data cannot be downloaded due to equipment or site malfunction the data can be accessed directly on PCMCIA flash cards at each site.

The east-side stations are located at existing spill or drainage sites where flow data has been collected by the Turlock and Modesto Irrigation Districts for several years. Upgrades at these sites involved the addition of YSI 600XL sondes, capable of measuring EC, stage and temperature. Each of these stations has been integrated with the current District SCADA systems (TID and MID use different SCADA systems, requiring different system integration solutions) and the data is supplied by e-mail to those individuals responsible for Task 5 of the SJR Dissolved oxygen TMDL project.

An ftp data archive site has been set-up for easy data uploading by District personnel –

The URL is:

http://esd1.lbl.gov/twiki/bin/view/SanJoaquin

The San Joaquin River stations (Lander Avenue and Maze Road) are currently operated by the Department of Water Resources. At these stations monitoring equipment, supplied by the project, has been (Maze Road) and will be (Lander Avenue), integrated with existing equipment and reported to DWR's CDEC website.

West-side tributary monitoring stations

There are thirteen west-side tributary monitoring sites in the program which are listed in Table 1.   Nine of these stations were newly constructed for the project and are listed below under the detailed description of the west-side upgraded stations. Existing stations Salt Slough, Mud Slough and Orestimba Creek are operated by the USGS and Los Banos Creek by the Grassland Water District. Los Banos Creek was recently rehabilitated after major flood damage during 2005/2006.

Table 1. West-side monitoring stations (* indicates a newly constructed station)

DO Site	Location	Site name	Average Flow (cfs)	Minimum Flow (cfs)	Maximum Flow (cfs)
19	West	Salt Slough at Lander Avenue	**239**	40	1,080
18	West	Mud Slough near Gustine	**170**	0	639
21	West	Orestimba Creek at River Rd.	**60**	0	1,280
20	West	Los Banos Creek at Highway 140 *	**51**	0	202
38	West	Marshall Road Drain *	**2**	0	11
64	West	Moran Drain *	**2**	0	60
65	West	Spanish Land Grant Drain *	**6**	0	124
36	West	Del Puerto Creek *	**9**	0	34
57	West	Ramona Lake Drain *	**nd**	0	nd
35	West	Westley Wasteway *	**3**	0	12
33	West	Hospital Creek *	**4**	0	22
34	West	Ingram Creek *	**10**	0	48
31	West	New Jerusalem Drain *	**6**	0	10

nd = no data

East-side tributary monitoring stations

There are 15 tributary monitoring stations on the east-side of the San Joaquin River (Table 2). Eight of these stations were chosen to upgrade with YSI 600XL electrical conductivity and temperature sondes. Since many of these stations measured flow using chart recorders it was decided to equip each of the sondes with a pressure transducer (optional add-on to YSI 600 XL) which would allow both water quality and stage information to be logged simultaneously. Most of the stations in both Turlock and Modesto Irrigation District were networked as part of the District's SCADA (Supervisory Control and Data Acquisition) systems. The SCADA systems deployed in MID and TID were acquired from different vendors hence the output signals from the YSI 600XL instruments required processing in a different way. Two of the MID sites did not have 110 volt power available and a digital to analog interface was purchased to allow the data flow from the sonde to the District's telemetry system.

Table 2. East-side monitoring stations (* indicates existing stations upgraded during project).

12	East	Stanislaus River at Caswell Park	**nd**	nd	nd
13	East	Stanislaus River at Ripon	**533**	217	4,350
14	East	Tuolumne River at Shiloh Bridge	**nd**	nd	nd
15	East	Tuolumne River at Modesto	**2,282**	270	8,600
16	East	Merced River at River Road	**nd**	nd	nd
17	East	Merced River near Stevinson	**1,162**	183	4,998
22	East	MID Lateral 4 to SJR *	**5**	0	49
23	East	MID Lateral 5 to Tuolumne River *	**13**	0	48
24	East	MID Lat 6 to Stanislaus River *	**26**	0	89
25	East	MID Main Drain to SJR. via Miller Lake *	**11**	0	142
26	East	TID Highline Spill *	**18**	0	104
27	East	TID Lateral 2 *	**3**	0	27
28	East	TID Westport Drain	**nd**	nd	nd
29	East	TID Harding Drain *	**35**	0	107
30	East	TID Lateral 6 & 7 at Levee *	**24**	0	85

nd = no data

San Joaquin River main-stem monitoring stations

There are eight San Joaquin River monitoring stations located along the mainstem of the River between Lander Avenue and Vernalis. The stations at Crows Landing and Fremont Ford are operated by the US Geological Survey. Flow, temperature and electrical conductivity are estimated at these stations. The remaining stations, with the exception of

Laird Park, which is a discrete sampling station, are operated by the Department of Water Resources. Of these electrical conductivity and temperature were measured at Lander Avenue, Mossdale, Vernalis and Patterson. An acoustic Doppler sensor was provided to the Department of Water Resources, Fresno for the Lander Avenue monitoring station to improve flow measurement at this location. The San Joaquin River is shallow and wide at the Lander Avenue Bridge and subject to occasional backwater conditions making it unsuitable for flow estimation using stage alone. The SONTEK SL acoustic Doppler sensor measures velocity directly and sends an acoustic beam that can span more than half the width of the river. At the time of writing, a metal boom has been developed to allow easy access to the SONTEK sensor for maintenance and to keep it secure and out of the way of potential vandals. Deployment is planned for late winter 2007.

A YSI 600XL sonde was also provided to the Department of Water Resources, Fresno to provide salinity and temperature data capability to the Maze Road flow station. Maze Road is located upstream of Vernalis and is an important real-time forecasting station for water quality in that it can be used to estimate requisite water quality releases from New Melones. Vernalis flow contains the New Melones operation – hence these flows need to be backed out to estimate the assimilative capacity of the River for contaminants. The EC/temperature sonde is operational and data is being relayed to DWR CDEC.

Table 3. San Joaquin River monitoring locations (* indicates upgrade stations).

DO Site	Location	Site name	Average Flow (cfs)	Minimum Flow (cfs)	Maximum Flow (cfs)
10	River	SJR at Lander Avenue *	**697**	3	7,923
9	River	SJR at Fremont Ford	**885**	135	4,350
8	River	SJR at Crows Landing	**2,499**	693	10,300
59	River	SJR Laird Park	**nd**	nd	nd
7	River	SJR at Patterson	**2,356**	689	12,921
6	River	SJR at Maze *	**nd**	nd	nd
5	River	SJR at Vernalis	**5,533**	520	16,200
4	River	SJR at Mossdale	**nd**	nd	nd

nd = no data

Detailed description of upgraded monitoring stations

West-side tributary monitoring stations (upgrades)

Site Description	**20. Los Banos Creek** Located within the Kesterson National Wildlife Refuge approximately ¼ mile south of Hwy 140.
Power	Solar Panel with 12-volt battery
Datalogger	Campbell Scientific datalogger
EC Sensor	Campbell Scientific temperature-compensated EC sensor
Flow Measurement	SONTEK SL acoustic Doppler sensor with built-in stage sensor
• Depth	Design Analysis H350XL with H355 Smartgas system
• Velocity	SONTEK SL
Telecommunications	GOES Telemetry
Current status	Site was recently rehabilitated in fall 2006. A new bridge was constructed replacing the wooden bridge that was severely damaged during 2005/2006. The SONTEK SL acoustic sensor was re-sited and new cable drawn (old cable was damaged). The EC sensor was replaced and a new pipe laid into the water for the bubbler sensor.

Site Description	**38. Marshall Road Drain** Located within Patterson Irrigation District at the east end of Marshall Road. Carries agricultural return flows from Marshall Road Reservoir.
Power	Solar Panel with 12-volt battery
Datalogger	Design Analysis datalogger
EC Sensor	YSI 600XL temperature compensated EC probe
Flow Measurement	Flow over a sharp crested weir with no contractions – weir equation using stage to compute discharge (primary) Unidata STARFLOW integrated stage/velocity acoustic Doppler transducer (secondary)
• Depth	Design Analysis H350XL with H355 Smartgas system (primary) Unidata STARFLOW stage (secondary)
• Velocity	Unidata STARFLOW velocity
Telecommunications	GOES Telemetry
Current status	Site currently operational. Leak in T valve on bubbler line found to be leaking on 5/9/06 – all flow data from bubbler unit suspect prior to this date. STARFLOW acoustic Doppler stage transducer prone to clogging. Potential power issue at site since all 3 monitoring systems are powered by a single panel and tied into the Spanish Land Grant Drain datalogger.

Site Description	**64. Moran Drain** Located within Patterson Irrigation District at the east end of Marshall Road. Carries agricultural return flows from adjacent fields.
Power	Solar Panel with 12-volt battery
Datalogger	Design Analysis datalogger
EC Sensor	YSI 600XL temperature compensated EC probe
Flow Measurement	Flow over a sharp crested weir with no contractions – weir equation using stage to compute discharge (primary) Unidata STARFLOW integrated stage/velocity acoustic Doppler transducer (secondary)
• Depth	Design Analysis H350XL with H355 Smartgas system (primary) Unidata STARFLOW stage (secondary)
• Velocity	Unidata STARFLOW velocity.
Telecommunications	GOES Telemetry
Current status	Site operational with few problems. Secondary STARFLOW acoustic Doppler stage transducer prone to clogging. Potential power issue at site since all 3 monitoring systems are powered by a single panel and tied into the Spanish Land Grant Drain datalogger.

Site Description	**65. Spanish Land Grant Drain** Located within Patterson Irrigation District at the east end of Marshall Road. Carries agricultural return flows from Marshall Road Reservoir.
Power	Solar Panel with 12-volt battery
Datalogger	Design Analysis datalogger
EC Sensor	YSI 600XL temperature compensated EC probe
Flow Measurement	Flow over a sharp crested weir with no contractions – weir equation using stage to compute discharge (primary) Unidata STARFLOW integrated stage/velocity acoustic Doppler transducer (secondary)
• Depth	Design Analysis H350XL with H355 Smartgas system (primary) Unidata STARFLOW stage (secondary)
• Velocity	Unidata STARFLOW velocity.
Telecommunications	GOES Telemetry
Current status	Site operational with few problems. Secondary STARFLOW acoustic Doppler stage transducer prone to clogging. Potential power issue at site since all 3 monitoring systems are powered by a single panel and both Moran and Marshall Road sensors are tied into the Spanish Land Grant Drain datalogger.

Site Description	**36. Del Puerto Creek** Ephemeral stream from the Coast Range that flows into the SJR through Patterson Irrigation District.
Power	Solar Panel with 12-volt battery
Datalogger	Design Analysis datalogger
EC Sensor	YSI 600XL temperature compensated EC probe
Flow Measurement	Stage-discharge relationship developed for a straight, narrowly incised and steep channel segment.
• Depth	Design Analysis H350XL with H355 Smartgas system;
• Velocity	n/a
Telecommunications	GOES Telemetry
Current status	Site operational with few problems. During low flow the steep bed slope causes low stage that is barely above bubbler elevation making low flow estimation prone to error. Some problems with vandalism – solar panel has been stolen once.

Site Description	**57. Ramona Lake Drain** Drain receiving pumped discharge from a small lake that acts as a drainage sump to surrounding fields. Site located on top of the levee adjacent to the SJR
Power	Solar Panel with 12-volt battery Auxiliary solar panels to power a 24 volt analog to digital transducer attached to the propeller meter.
Datalogger	Design Analysis datalogger
EC Sensor	YSI 600XL temperature compensated EC probe
Flow Measurement	Stage-discharge relationship developed for a sharp crested weir with no contractions (primary) and a propeller meter (secondary). System will be replaced by a MACE integrated stage/velocity Doppler transducer because of the hazardous nature of the site and the fact the propeller meter is no longer operational.
• Depth	Design Analysis H350XL with H355 Smartgas system. MACE pressure transducer (secondary)
• Velocity	n/a
Telecommunications	GOES Telemetry
Current status	Recent San Joaquin River flooding during 2005/2006 damaged the culvert permitting reverse flow from the River into the District. The landowner dropped sandbags down the culvert to avert flooding his land and decommissioned the monitoring station. Culvert has only recently been repaired. Existing weir was removed. A MACE Doppler system is the best solution to provide flow data at the site.

Site Description	**35. Westley Wasteway** Located along River Road within the West Stanislaus Irrigation District
Power	Solar Panel with 12-volt battery
Datalogger	Design Analysis datalogger
EC Sensor	YSI 600XL temperature compensated EC probe
Flow Measurement	Previously used a combination of STARFLOW acoustic Doppler transducer and bubbler stage. Current retrofit uses a regular contracted weir located approximately 30ft downstream. Flow measured using equation for contracted sharp crested weir.
• Depth	Design Analysis H350XL with H355 Smartgas system (primary)
• Velocity	n/a
Telecommunications	GOES Telemetry
Current status	Original culvert which was undersized replaced with a larger diameter structure which accommodates more flow. Weir structure is more accessible and easier to check than STARFLOW acoustic Doppler sensor.

Site Description	**33. Hospital Creek** Located along River Road within the West Stanislaus Irrigation District. Hospital Creek is an ephemeral stream originating in the Coast Range.
Power	Solar Panel with 12-volt battery
Datalogger	Design Analysis Datalogger
EC Sensor	YSI 600XL temperature compensated EC probe
Flow Measurement	Flow over a lsharp crested weir with minor contractions – weir equation using stage to compute discharge
• Depth	Design Analysis H350XL with H355 Smartgas system
• Velocity	n/a
Telecommunications	GOES Telemetry
Current status	Site operational with few problems. Occasional high sediment load during summer months may necessitate cleaning of EC probe and surrounding screen.

Site Description	**34. Ingram Creek** Located along River Road within the West Stanislaus Irrigation District. Ingram Creek is an ephemeral stream originating in the Coast Range.
Power	Solar Panel with 12-volt battery
Datalogger	Design Analysis datalogger
EC Sensor	YSI 600XL temperature compensated EC probe
Flow Measurement	Flow over a sharp crested weir with no contractions – weir equation using stage to compute discharge
• Depth	Design Analysis H350XL with H355 Smartgas system
• Velocity	n/a
Telecommunications	GOES Telemetry
Current status	Site operational with few problems. Heavy sediment load during summer months necessitates frequent cleaning of EC probe and surrounding screen.


Site Description	**34. New Jerusalem Drain** Located ¼ mile north of the Banta Carbona Irrigation District fish facility
Power	Solar Panel with 12-volt battery
Datalogger	Design Analysis datalogger
EC Sensor	YSI 600XL temperature compensated EC probe
Flow Measurement	MACE integrated stage/doppler sensor providing direct discharge output (primary). Flow over a sharp crested weir with no contractions – weir equation using stage to compute discharge (secondary)
• Depth	Design Analysis H350XL with H355 Smartgas system (primary) MACE pressure sensor (secondary)
• Velocity	MACE acoustic Doppler sensor
Telecommunications	GOES Telemetry
Current status	Site was upgraded with a Unidata STARFLOW integrated stage/Doppler sensor which failed after six months of placement. Unit was replaced in mid-2006 with a MACE integrated stage/velocity acoustic sensor which has proved more reliable.

Detailed description of upgraded monitoring stations

East-side tributary monitoring stations (upgrades)

Site Description	**22. MID Lateral 4** Modesto irrigation district operational outflow
Power	110 volt power
Datalogger	YSI 6500 Process Monitor which send data to a Sierra Systems SCADA RTU.
EC Sensor	YSI temperature compensated EC probe located ¼ mile upstream of the weir (drop leaf gate)
pH Sensor	YSI pH probe located ¼ mile upstream of the weir (drop leaf gate)
Flow Measurement	Flow over a sharp crested weir (drop leaf gate) – weir equation using stage to compute discharge
• Depth	Sierra Systems transducer reporting directly to RTU (prmary) Stevens chart recorder (secondary) YSI 600XL internal pressure sensor (tertiary)
• Velocity	n/a
Telecommunications	Sierra Systems RTU SCADA Telemetry
Current status	Site operational .

Site Description	**23. MID Lateral 5** Modesto irrigation district operational outflow
Power	12 volt power supplied by battery and solar panel
Datalogger	Campbell Scientific CR-10 with digital to serial interface to process signal and make compatible with Sierra Systems SCADA RTU.
EC Sensor	YSI temperature compensated EC probe
pH Sensor	YSI pH probe
Flow Measurement	Flow over a sharp crested weir – weir equation using stage to compute discharge
• Depth	Sierra Systems transducer reporting directly to RTU (primary) Stevens chart recorder (secondary) YSI 600XL internal pressure sensor (tertiary)
• Velocity	n/a
Telecommunications	Sierra Systems RTU SCADA Telemetry
Current status	Site operational .

Site Description	**24. MID Lateral 6** Modesto irrigation district operational outflow
Power	110 volt power
Datalogger	YSI 6500 Process Monitor which send data to a Sierra Systems SCADA RTU.
EC Sensor	YSI temperature compensated EC probe located upstream of the weir
pH Sensor	YSI pH probe located upstream of the weir
Flow Measurement	Flow over a sharp crested weir – weir equation using stage to compute discharge
• Depth	Sierra Systems transducer reporting directly to RTU (prmary) Stevens chart recorder (secondary) YSI 600XL internal pressure sensor (tertiary)
• Velocity	n/a
Telecommunications	Sierra Systems RTU SCADA Telemetry

Site Description	**25. MID Main drain** Modesto irrigation district operational outflow. Canal empties into Miller Lake.
Power	12 volt power supplied by battery and solar panel
Datalogger	Campbell Scientific CR-10 with digital to serial interface to process signal and make compatible with Sierra Systems SCADA RTU.
EC Sensor	YSI temperature compensated EC probe
pH Sensor	YSI pH probe
Flow Measurement	Flow over a sharp crested weir – weir equation using stage to compute discharge
• Depth	Sierra Systems transducer reporting directly to RTU (primary) Stevens chart recorder (secondary) YSI 600XL internal pressure sensor (tertiary)
• Velocity	n/a
Telecommunications	Sierra Systems RTU SCADA Telemetry

Site Description	**26. TID Highline Canal** Turlock Irrigation District operational spill/drainage site
Power	110 volt power
Datalogger	Sierra Controls RTU with SCADAPACK
EC Sensor	YSI 600XL temperature compensated EC probe
Flow Measurement	Flow over a long sharp crested weir – weir equation using stage to compute discharge
• Depth	Sierra Controls float and shaft encoder (primary) YSI 600XL internal pressure sensor (secondary)
• Velocity	n/a
Telecommunications	Sierra Controls SCADAPACK Telemetry
Current status	Site operational

Site Description	**27. TID Lateral 2** Turlock Irrigation District operational spill/drainage site
Power	110 volt power
Datalogger	Sierra Controls RTU with SCADAPACK
EC Sensor	YSI 600XL temperature compensated EC probe
Flow Measurement	Flow over a long sharp crested weir – weir equation using stage to compute discharge
• Depth	Sierra Controls float and shaft encoder (primary) YSI 600XL internal pressure sensor (secondary)
• Velocity	n/a
Telecommunications	Sierra Controls SCADAPACK Telemetry
Current status	Site operational

Site Description	**28. TID Westport Drain** Turlock Irrigation District operational spill/drainage site
Power	110 volt power
Datalogger	Sierra Controls RTU with SCADAPACK
EC Sensor	YSI 600XL temperature compensated EC probe
Flow Measurement	Flow over a long sharp crested weir – weir equation using stage to compute discharge
• Depth	Sierra Controls float and shaft encoder (primary) YSI 600XL internal pressure sensor (secondary)
• Velocity	n/a
Telecommunications	Sierra Controls SCADAPACK Telemetry
Current status	Site operational

Site Description	**29. TID Harding Drain** Turlock Irrigation District drainage site
Power	110 volt power
Datalogger	Sierra Controls RTU with SCADAPACK
EC Sensor	YSI 600XL temperature compensated EC probe
Flow Measurement	Flow over a long sharp crested weir – weir equation using stage to compute discharge
• Depth	Sierra Controls float and shaft encoder (primary) YSI 600XL internal pressure sensor (secondary)
• Velocity	n/a
Telecommunications	Sierra Controls SCADAPACK Telemetry
Current status	Site operational

Site Description	**30. TID Lateral 6 & 7** Turlock Irrigation District operational spill/drainage site
Power	110 volt power
Datalogger	Sierra Controls RTU with SCADAPACK
EC Sensor	YSI 600XL temperature compensated EC probe
Flow Measurement	Flow over a long sharp crested weir – weir equation using stage to compute discharge
• Depth	YSI 600XL internal pressure sensor (primary) ISCO 4250 flow measurement transducer will be installed during spring 2007 (will become primary)
• Velocity	n/a
Telecommunications	Sierra Controls SCADAPACK Telemetry
Current status	Site operational

APPENDIX A

STANDARD OPERATING PROCEDURES MANUAL

FOR

NEW AND UPGRADED CONTINUOUS FLOW, EC AND TEMPERATURE MONITORING STATIONS FOR TRIBUTARY INFLOW TO THE SAN JOAQUIN RIVER

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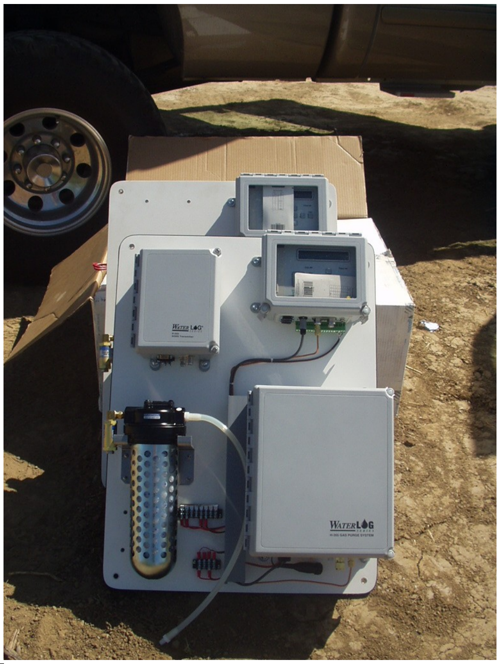
Appendices

WEST-SIDE INFLOW MONITORING STATIONS



QA PROCEDURES – EC/TEMP/STAGE MONITORING

The following procedures describe the actions that should be followed to obtain reliable stage, flow, temperature and electrical conductivity data from the YSI 600XL sondes and Design Analysis H350XL pressure sensing systems located at the new and upgraded inflow monitoring stations on the west-side of the San Joaquin River.

Field notebook

The field notebook should be stamped, labeled with the date, appropriate site name and name of the individual(s) performing the quality assurance check.

DATE : (mm/dd/yy)
SITE NAME : (xxxxxxxxx)
NAME : (xxxxxx xxxxxxxx)

Myron EC Calibration Instrument

The preferred instrument for performing quality assurance checks is the Myron Model 4P or 6P (www.myronl.com). This instrument has been found to be easy to use, calibrate and maintain and is extremely robust. In over 5 years of use, these instruments hold their calibration for electrical conductivity (EC) very well and do not need to be calibrated for temperature. Electrical conductivity temperature compensation is fully automatic.

The Myron EC meter should be calibrated using EC standard solution in the laboratory before being used in the field. Calibration should be re-checked at the end of the day to double-check instrument stability. The electrical conductivity solution of choice is either a potassium chloride (KCl) solution of 1413 uS/cm available from www.caprockdev.com or the Myron 442 standard solution, an admixture of sulfate, carbonate and chloride waters, and available from Myron Inc. (www.myronl.com).

Myron Calibration Procedure

The recommended calibration procedure for EC is as follows :

- **Solution selection**

  1. Press **COND** to select the parameter on which to check or adjust the solution type.
  2. Press and hold **CAL/MCLR** key for about 3 seconds to make SEL appear.
  3. Use **^ /MS** or **MR/v** key to obtain the type of solution desired. The solution type will be displayed as **KCl, NaCl, 442** or **User**.
  4. Press **CAL/MCLR** to accept the new solution type.

- **Myron calibration**

  1. Rinse conductivity cell three times with proper standard (KCl or 442 solution).
  2. Refill conductivity cell with the same standard.
  3. Press **COND**
  4. Press **CAL/MCLR** - the **CAL** icon will appear on display
  5. Press **^ /MS** or **MR/ v** to step the displayed value toward the standard's value.
  6. Press **CAL/MCLR** - once to confirm the new value and end the calibration sequence for the particular solution type.

- **Myron San Joaquin River sample collection**

  1. Rinse call cup 3 times with sample to be measured by dipping into the river close to the YSI sonde location (this conditions the temperature compensation network and prepares the cell).
  2. Refill cell cup with a sample taken from the same location.
  3. Press **COND.**
  4. Take reading. A display of [----] indicates and over-range condition. This is the reading that will be used to calibrate the YSI 600XL instrument.

YSI 600XL Sonde w/ YSI 650 MDS Handset

- **YSI sonde maintenance**
  1. Withdraw the YSI 600XL sonde from the stilling well.

2. Remove the protective end cap by twisting counterclockwise to access the EC and temperature sensors.
3. Use small brush provided and clean ports of the EC probe rinsing with clean water from a wash bottle until all attached biofilms and debris are removed. Check visually.
4. Clean the temperature sensor by wiping with a soft cotton rag.
5. Check the stilling well and plunge with a long closed tube if necessary to make sure that water is flowing freely through the holes at the end of the pipe.
6. Replace the protective end cap and reinsert the YSI 600XL sonde making sure that the cable is securely connected to the stilling well casing and the sonde and is taught when the sonde is in position.

- **In-situ electrical conductivity calibration**

1. First check to make sure that the Temperature and Specific Conductivity sensors have been activated. Select **Sensor** from the 'main menu'. An "*" should appear opposite the appropriate parameter i.e. **2- (*) Temperature** and **3- (*) Conductivity**
2. If either **Temperature** or **Conductivity** is not checked – type the number or letter that corresponds to that parameter. The asterisk indicates the sensor is enabled.
3. Check to make sure that Temperature and Specific Conductivity are being reported by selecting **Report** from the 'main menu'. An "*" should appear opposite the appropriate parameter i.e. **3- (*) Temp C** and **4- (*) SpCond mS/cm**
4. If **Temperature** or **SpCond** (specific conductance) are not checked – type the number or letter that corresponds to that parameter.
5. A submenu will appear beneath each parameter chosen that allows the user to select units. Select the number that corresponds to **Temp (F)** and **uS/cm** in the "select units" menu.
6. Press **Esc** or **0** to return to the main menu.
7. From the sonde main menu screen select **Calibrate.**
8. From the calibration menu select **1 – Conductivity** to access the conductivity calibration.
9. Select **1- SpCond** to access the specific conductance calibration procedure.
10. Type in the final stable value of electrical conductivity obtained from the Myron Ultrameter. Press **Enter** for the value to be accepted.
11. Observe the readings under **Specific Conductance** for approximately 30 seconds. If they show no significant change at 30 seconds, press **Enter.** The screen will indicate that the calibration has been accepted and will prompt you to press **Enter** again to return to the **Calibrate** menu.
12. Press **Esc** or **0** to return to the main menu.
13. The sonde is now calibrated for electrical conductivity.

- **Depth and level sensor calibration**

1. From the sonde main menu screen select **Calibrate.**

2. From the calibration menu select **3 – Pressure-Abs** to access the depth calibration procedure.
3. Input the measured sensor **offset** in feet. The offset is the reading that must be added to the stage reading to agree with the staff gauge reading.
4. Press **Enter** and monitor the depth reading over about 30 seconds until the readings stabilize.
5. Press **Enter** again to confirm the calibration.
6. Press **Enter** a third time to return to the **Calibrate** menu.
7. If the sonde stage does not agree with the staff gauge reading :
    a. first check that the sonde is properly seated in the stilling well and that the support cable is fully extended.
    b. Next check the offset by measuring the distance between the sonde stage sensor (located above the EC sensor on the side of the sonde body) and the water surface. It might be helpful to make two measurements – between the sonde pressure sensor and the top of the stilling well and from the top of the stilling well to the water surface. The offset is the difference in these reading.
    c. Recalibrate the instrument with the new offset reading.
    d. Repeat steps 5 and 6.
8. Press Escape (**Esc**) to return to the main menu.

General strategies for sonde deployment

The sonde should be deployed in the stilling well to a depth that submerges all of the sensors, but not so deep that the sonde disrupts the bottom sediments, clouding the data collection with particles in suspension.

Post field measurement electrical conductivity QA check

After returning from the field the Myron Ultrameter EC calibration should be checked using the same standard solution used in the initial calibration. Both initial and final readings should be entered into the field notebook in adjacent boxes or on the same line for ease of analysis. Any discrepancy should be noted.

Field notebook Before leaving the sampling site, ensure that all sensor leads have been reconnected and enclosures locked. Additionally, as this point the **field sheet** must be filled out in its entirety for that specific site.

Design Analysis H 350XL Logger and H355 Smartgas System

The Design Analysis Smartgas system is a maintenance free stage sensor which emits a stream of air bubbles into the water column through an orifice tube. The back pressure required to force the bubbles out of the emitter is measured using a sensitive pressure transducer which converts this pressure to a stage measurement. The Smartgas system has been programmed to purge the orifice line once per day at noon. There should be no additional maintenance required of the gas line.

If a gas leak is suspected at any time a bottle of **SNOOP** (liquid soap) can be used to help detect leaks along the orifice line and more particularly at all fittings. A leak may be fixed by tightening the fitting, replacing a length of orifice tube (sometimes it is best to replace the entire length to avoid potential leaks at connections or replacing the fitting.

- **<u>Stage sensor calibration in dry conditions</u>**

    1. Using a 1 liter measuring cylinder – fill the cylinder to a depth of 1.5 feet.
    2. Make sure there is rubber tubing attached to the two way valve that sits below the Smartgas enclosure. Insert tubing into the cylinder making sure the tubing reaches the bottom of the measuring cylinder.
    3. Turn the valve to divert compressed air from the orifice line to the tubing inserted into the measuring cylinder
    4. Turn on the **H350XL** display by depressing the on/off key
    5. Read the current stage on the display. If the reading on the display is different from 1.5ft (or some other depth of water chosen) adjust the stage offset as follows :
        a. Scroll down to **Scan Setup**. Depress right arrow to get to the status screen. Toggle the scanning setting and **turn scanning off.** (Failure to turn scanning off will result in erroneous offset values).
        b. Depress left arrow twice to move back to the main menu.
        c. Scroll down to **Sensor Input Setup**
        d. Select **stage setup**
        e. Scroll down one line to **Offset**.
        f. Depress **Enter** key. Enter a new offset that will adjust the stage value to match the depth of water column above the bottom of the orifice line in the measuring cylinder.
        g. Depress **Enter** once again to set new offset.
        h. Depress left arrow twice to move back to the main menu.
        i. Scroll down to **Scan Setup**. Depress right arrow to get to the status screen. Toggle the scanning setting and **turn scanning on.**
        j. Depress the left arrow twice to get back to main menu.
        k. **Turn off** the display using on/off key

- **<u>Normal stage sensor calibration</u>**
    - Turn on the **H350XL** display by depressing the on/off key

- Read staff gauge reading.
- Read the current stage on the display. If the reading on the display is different from the staff gauge adjust the stage offset as follows :
    - Scroll down to **Scan Setup**. Depress right arrow to get to the status screen. Toggle the scanning setting and **turn scanning off.** (Failure to turn scanning off will result in erroneous offset values).
    - Depress left arrow twice to move back to the main menu.
    - Scroll down to **Sensor Input Setup**
    - Select **stage setup**
    - Scroll down one line to **Offset**.
    - Depress **Enter** key. Enter a new offset that will adjust the stage value to match the depth of water column above the bottom of the orifice line in the measuring cylinder.
    - Depress **Enter** once again to set new offset.
    - Depress left arrow twice to move back to the main menu.
    - Scroll down to **Scan Setup**. Depress right arrow to get to the status screen. Toggle the scanning setting and **turn scanning on.**
    - Depress the left arrow twice to get back to main menu.
    - **Turn off** the display using on/off key

APPENDIX A-1. Field Data Sheets and Data Quality Summary Form

Data Quality Form: Completeness

Monitoring Group Name			Project ID	
Your Name			Quality Assurance Leader	
Date				
Parameter	**Collection Period**	**No. of Samples Anticipated**	**No. Valid Samples Collected and Analyzed**	**Percent Complete**
Temperature ^{o} F				
Stage (ft)				
Electrical Conductivity (umhos/cm)				

Comments:

Instrument Calibration Frequency and Quality Control

Conventional Water Quality Parameters			
Equipment Type	**Calibration Frequency**	**Standard or Calibration Instrument Used**	**QC session**
Temperature	Every 6 months	NIST calibrated or certified thermometer	Twice a year
Conductivity	Every sampling day – typically monthly	Myron Ultrameter calibrated prior to field and checked after field – calibrated with conductivity standard.	Twice a year

APPENDIX A-2. Quality Assurance Sample Field Form

FIELD QUALITY ASSURANCE CHECKLIST

Station Name:__ xxxxxxxxx xxxxxxx **Julian Day** xx

NAMES		DATE	2/3/2005
		TIME	9:09 AM

STAGE	Time	Data Source	Stage reading (ft)	Calc. Offset (ft)
Bubbler	10:15	Los Banos Creek	5.71	0.04
Staff gage	9:09	LBC-ht	5.75	

EC	Time	Standard EC	Measured EC	% Deviation
Station Reading	10:15		1259	93.12
Myron Ultrameter	9:09	LBC-EC_ulm	1352	

WATER TEMPERATURE	Time	Data Source	Value Deg. F
Station Reading	10:15	Temp_F	50.14
Myron Ultrameter	9:09	LBC-T-ulm	50.1

DISCHARGE	Time	Data Source	Velocity (ft/s)	Discharge (cfs)
Estimate based on stage/velocity	10:15	Rating	0.66	

NOTES:

APPENDIX A-3. Map of Sampling Sites